

An Evaluation of Precaution-based Approaches As EMF Policy Tools in Community Environments

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This paper explores the use of precaution-based approaches as policy tools when responding to concerns about power-frequency electric and magnetic fields (EMF) in community environments. The combination of public concern and scientific uncertainty about potential health impacts from exposure to EMF challenges society to adopt EMF policies that balance the benefits of electric power against the possibility that some aspect of the use of electricity may be harmful. Inappropriate policy responses can undermine the economics of society's use of electricity and have other adverse consequences on public health. These adverse consequences result from the inappropriate diversion of scarce public and private resources. Precaution-based approaches are rooted in individual concepts of common sense and can be an effective component of a comprehensive set of EMF policy options. Precaution-based approaches do not replace science-based policy options and should only be used when the available science-based guidelines are not applicable. The application of these approaches should balance the real and expected costs and benefits of taking or not taking action. Given our current scientific knowledge, actions taken to reduce EMF exposure should necessarily be low cost because the expected benefits are uncertain. Society also needs to avoid adopting EMF policies that could incur high costs from distorting resources from other, more important, personal and public health priorities. *Key words:* common sense, prudent avoidance. *Environ Health Perspect* 104:908–911 (1996)

There is public and scientific concern that power frequency (50/60-Hertz) electric and magnetic fields (EMF) in residential settings influence cancer or other diseases. While the issue of a relationship between EMF and cancer has been the focus of research (1–2), results have not established a connection between EMF exposures and cancer or other diseases (3–5). The scientific community has been unable to resolve public concern and is uncertain what conclusions will result from future research. The scientific questions will be resolved in due course by the normal scientific process of research, peer review, and debate. Scientists cannot predict how long it will take to answer the remaining key questions, but it is likely to be several years. In the meantime, the combination of public concern and scientific uncertainty challenges society to adopt policies that balance our needs for and value of electrical power against the possibility that some aspect of the use of electric power may be harmful. This balancing is not unique to the EMF issue and is a fundamental goal of individual or societal decision making for a wide range of issues.

Science-based evaluations of the potential hazards from EMF exposure are an essential part of an appropriate public policy response. The traditional method of setting science-based policy, exposure standards, or health guidelines for potentially harmful agents has been to first obtain firm data concerning hazard and dose response

and then set threshold exposure levels with appropriate margins of safety. This method has been used by quasi-governmental scientific panels in evaluating the need for and setting EMF exposure guidelines (6). Because of insufficient evidence for a health hazard, inconsistent results from research programs, and relying on well-accepted biophysical principles, these expert panels have consistently concluded that there is insufficient evidence of a hazard for EMF exposures (6).

This response from the scientific community has limited regulatory policy options and has not resolved public concern. Precaution-based policy approaches incorporate information about the scientific uncertainty, address the possibility of a health risk being identified in the future, and provide a means to respond to public requests for meaningful actions today. These policy responses can fill the gap between the time when the public becomes aware of an issue and when the scientific community provides a firm determination of the potential risk. These precaution-based policy approaches should be seen in addition to, not as substitutes for, the science-based evaluations. This paper explores the use of precaution-based approaches as a means of assisting regulatory decision makers, electric utilities, and the public in responding to the evolving EMF controversy. Our goals are to elaborate on the rationale of precaution-based policy approaches and provide criteria that help

define when they should be used with regard to the EMF issue.

The EMF Science

EMF naturally results from the generation, distribution, and use of electricity. Community exposure results from electric utility transmission and distribution facilities, internal wiring of buildings, the use of electric appliances and equipment, and ground return currents (7,8). A brief overview of the EMF science will help provide a context for the subsequent policy discussion. An electric field is a natural force field created by voltage. The strength of these fields is measured in units of volts per meter (7,8). A magnetic field is also a natural force field produced by the flow, or current, of electricity. The strength of the magnetic field is measured in units of microtesla (7,8). In spite of the substantial amount of research performed over the past 25 years, scientists still struggle to answer four fundamental questions. Can electric or magnetic fields found in community environments influence health? If they can, what are the biologically important characteristics of exposure? If there is a health risk, who is at risk, and how large is the risk? What steps can be taken to reduce the risk (if one exists at all)? There are well-established biophysical models for the interaction of EMF with biological systems (9); however, these biophysical models do not support the possibility of significant health impacts from magnetic fields in the range found in community environments (i.e., up to 1,000 mG) (10). New biophysical models have been proposed to explain how magnetic fields under 1,000 mG could interact with cells, but these do not enjoy wide acceptance within the relevant scientific community or from experimental evidence (9).

Neither the parameters of the risk from EMF exposure, if it exists, nor the size of the population at risk, if any, are known. If there is a risk to health from EMF exposure, those at risk could be a relatively few sensitive people with a consequent low public health impact or a larger part of the pop-

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ulation with a lower but more widespread risk. Since the scientific community has no operational or theoretical model of dose, our ability to define exposure or to identify populations who may be more exposed is limited. Not being able to answer the fundamental scientific questions about the presence of a risk or the relevant characteristics of exposure hampers our ability to direct scientific resources to specific research questions, to establish new science-based exposure mitigation policies, and to engage in a public policy debate about their costs and benefits. It is hoped that new results from the international research efforts now underway will adequately answer these scientific and public health questions, establish clear policy directions, and resolve the public concerns.

Why Are EMF Policies Important?

Even though there is no scientific consensus that EMF exposures influence health, it is important that we develop and implement effective policies that respond to the scientific uncertainty and public concern. The use of electricity is ubiquitous throughout society. In both developed and developing countries, the reliable and economic availability of electricity is essential to economic progress and maintaining public health. Because the use of electricity is so widespread, questions relating to its safety are important. The proven value of electricity to the economic and public health of our society demands that care be taken in determining what policy measures to adopt. Without such care, and particularly if there are no health impacts from EMF, unanswered public concerns about health questions may result in wasting individual and society resources. This has the potential to impact on the reliability and cost of society's use of electricity, and have other adverse consequences on public health by diverting limited public and private resources from known public health risks. Reasons for implementing effective EMF policies at this time include maintaining the fundamental public health value of electricity to our society, responding to the uncertainty about the nature of the possible risk, and the need to build new electric utility facilities and maintain the reliability of existing facilities.

The Policy Construct for Precaution-based Approaches

Our challenge is to identify and implement effective policy options that incorporate the current scientific knowledge and enjoy the wide acceptance of society. People within our society consistently use concepts of

precaution in everyday life, both personally and in their organizations. Generally, these are not well defined and can include a variety of actions. Precaution-based approaches provide opportunity to implement interim policies that are meaningful. In the context of the EMF issue, precaution-based approaches describe a particular set of possible actions that are consistent with individual and societal concepts of acting sensibly. This includes funding research to resolve the scientific questions, informing members of our society about the scientific issues, and implementing interim steps to reduce the possible risk from EMF by eliminating or limiting exposure, when this can be done at modest cost and with minimum inconvenience. These approaches are based on 1) the recognition that a hazard may or may not actually exist; 2) their applicability mainly to new facilities; 3) their low costs; 4) the fact that they do not distort public priorities; and 5) their use for a transitional period. Specific precaution-based EMF policy responses maintain their value when these five elements are balanced.

The explicit recognition that a true risk may not exist is a key element of precaution-based approaches because this helps keep the issue in perspective. If the scientific community concludes that there is no risk from EMF exposure or that the possibility of a risk is too speculative, then we should respond to public concern with an effective education program. If, on the other hand, a risk for EMF were to be established, it would then be appropriate to rely on the scientific community to recommend specific protective measures using established public health risk assessment/risk management criteria (11). Within the context of electric utility facilities, actions taken under this kind of policy approach should generally be reserved for the design, siting, and construction of new facilities because of the flexibility and economy that is available when new facilities are constructed. Actions taken are limited to no- or low-cost because higher cost actions are inappropriate due to the uncertainty of achieving any health benefits. Avoiding the distortion of public health priorities is a critical element because it would be a mistake to divert scarce resources from something with known benefits to the uncertain benefits of reducing exposures to EMF. It is important that information about potential health risks be presented to individuals and society so that they allocate attention to the full range of personal and public health issues to achieve greatest benefit. Because the risk is uncertain, actions taken should be transitional. As new information becomes available to either clarify the presence or absence of a risk, to better

define the relevant characteristics of exposure, or to identify ways to efficiently reduce EMF exposure, actions should be appropriately modified. As a more fundamental concept, if a risk is established to actually exist, the public health-based risk assessment and risk management model would provide the more appropriate and necessary guidance upon which to base individual and societal allocation of resources (11). If a risk is not identified, then the scientific community and public health agencies should implement effective education programs to resolve public concerns.

Existing Precaution-based Approaches

With respect to the EMF issue, the concept of precaution-based policies had its genesis in the United States around 1989 when prudent avoidance was proposed as a policy option in a report to the Office of Technology Assessment of the U.S. Congress (12). Nair et al. (12) described prudent avoidance as

looking systematically for strategies which can keep people out of 60 Hz fields arising from all sources but only adopt those which look to be "prudent" investments given their cost and our current level of scientific understanding about possible risks.

In several jurisdictions of the United States, steps to site and construct new facilities include consideration of options to reduce EMF. For example, as part of the siting of a new 220kV transmission line, the California Public Utilities Commission ruled that the evidence for risk was insufficient to mitigate fields under the California Environmental Quality Act, but it would be appropriate to take other precautionary steps (13). These steps included education about EMF to the affected public and taking EMF into consideration in the design and siting of the new line, when these are low cost (13). California (14) has since adopted a set of generic policies that include reducing EMF from new transmission and distribution facilities by balancing reliability, safety, and cost effectiveness. California's electric utilities have developed formal design guidelines to reduce EMF from new electric utility facilities. The California Public Utilities Commission has defined no-cost and low-cost steps as those which total less than 4% of the total project costs (14).

The Colorado Public Commission has described the state's concept of prudent avoidance:

The utility shall include the concept of prudent avoidance with respect to planning, siting, construction, and operation of transmission facilities. Prudent avoidance shall

mean the striking of a reasonable balance between the potential health effects of exposure to magnetic fields and the cost of impacts of mitigation of such exposure, by taking steps to reduce the exposure at reasonable or modest cost. Such steps might include, but are not limited to 1) design alternatives considering the spatial arrangement of phasing of conductors; 2) routing lines to limit exposures to areas of concentrated population and group facilities such as schools and hospitals; 3) installing higher structures; 4) widening right of way corridors; and 5) burial of lines.

Some health departments have also adopted policies or published informational literature that recommend prudent avoidance as a policy tool. The Hawaii Department of Health recommends a prudent avoidance policy that includes taking "...reasonable, practical, simple, and relatively inexpensive actions... to reduce exposure" (16). The Connecticut Department of Health Services requested the Connecticut Academy of Science and Engineering to address the EMF policy question. Their report concluded that it would be inappropriate for health authorities to recommend prudent avoidance to the general public (17). However, the Connecticut Siting Council did order the electric utilities to follow electric and magnetic field best management practices (17). These are implemented on a project-specific basis and include public notice and participation and the use of low-EMF designs for new facilities.

In Australia, the electric utility industry, through its trade association, the Electricity Supply Association of Australia Limited (ESAA), has adopted a policy of acting prudently in relation to the EMF issue. ESAA has stated that acting prudently includes practicing prudent avoidance when building new transmission and distribution facilities. In New Zealand, a similar approach has been taken by the electric transmission authority, which won its judicial approval in a 1994 siting case.

Several Nordic health agencies have advocated the use of caution in their policy approach to the EMF issue (e.g., Sweden, Denmark, Norway). All of these agencies assessed the EMF scientific literature and concluded that adverse health effects from exposure to EMF have not been established. The Nordic health agencies agreed that there is some evidence that EMF exposure may pose a risk to health and they suggest a cautious approach when building new electrical facilities, homes, and schools (including kindergartens and child care structures) near existing electrical facilities such as powerlines and substations. However, all have rejected imposing arbitrary low numeric EMF exposure levels

since these are not supported by the scientific literature. The policy of the Swedish Radiation Protection Institute suggests that low cost mitigation action be considered when EMF exposure levels reach 10 times what would be considered normal for that particular environment.

Interest has also been expressed in relation to prudent avoidance for new schools and residential/office building development. Particular interest in the concept for schools has been shown in California (18), New York, New Jersey, Canada, and Sweden. This has resulted in restrictions for siting these new schools close to electric utility facilities and in informing parents and teachers about the sources and field strengths in classroom and play areas. Remodeling plans have also been reviewed to take advantage of opportunities to reduce fields. The basis for these approaches is to address concerns about proximity to transmission lines, not to limit exposures to EMF per se.

Why Precaution-based EMF Policies Make Sense

Precaution-based policy approaches make sense because they provide an opportunity to take incremental steps to improve the desirability of the future with respect to emerging issues. Prudence or caution can be implemented by individuals, businesses, or government, but is not a justification for costly actions (19). To await the outcome of the scientific process before adopting semi-formal prudent policy responses could mean missed opportunities to include a wider range of interests and take simple steps to reduce or modify the EMF environment at low cost. The use of this policy tool does not replace science-based policy options but it should incorporate current scientific knowledge into the decision process.

These precaution-based policies include the provision of information that assists individuals to better understand the sources of EMF and thus identifies options that people can take to limit their exposure. To exercise such a choice, individuals need to be provided with information about sources of EMF exposure. This information can help empower individuals to take advantage of decision-making processes. Public education material on EMF provides this kind of information and gives people and organizations the opportunity to make such informed choices.

Wolves Dressed as Sheep: Nonscience-based Numeric Standards

Science-based numeric standards for EMF enjoy wide acceptance (8). Some jurisdictions have adopted or considered adopting

nonscience-based numeric standards under the guise of being cautious or prudent or as part of an ALARA (as low as reasonably achievable) type response. In reality, they are neither cautious nor prudent. They represent an attempt to give the illusion of certainty to what is inherently uncertain. Such a policy response was argued for in Australia, but was rejected (20):

Any standards fixed for the purpose of avoiding the possible risk to health created by the fields would be based only on guesswork. They might either give a sense of false security or create unnecessary alarm, but in any case they would serve no useful purpose, having no rational basis.

Emphasis was placed on the fundamental problems associated with the lack of knowledge regarding exposure and dose (20):

It is not known at what threshold of exposure (if any) a risk arises or what conditions are necessary to create a risk. If the suggestion that a risk exists at a level of exposure as low as 2-3 mG is correct, the difficulties of avoiding the risk will be great, for levels of ambient exposure as low as that are likely to be common. However, it has not been established under what conditions the risk, if any, arises. It is by no means clear whether the risk (if any) is created by intensity of exposure, duration of exposure, occasional bursts of exposure at higher than usual frequency or intensity, or intermittent exposure. It is not established whether or not a dose-response relationship exists, or whether the risk (if any) arises at a threshold, or in windows, of intensity.

Approaches incorporating a numeric standard are not an appropriate EMF policy option because a hazard has not been established to exist, dose has not been defined, it is impossible to define exposure in the context of human health impacts, and the emergence of new technologies is not expected to provide additional policy options. ALARA type responses are also inappropriate to the EMF issues because they do not provide guidance as to what is reasonable in the context of the EMF issue. While it may be difficult to implement a well-defined set of actions that are part of precaution-based approaches, the very lack of definition is the source of its strength. Problems are created when decisions are based on precaution-based approaches but are implemented through overly constructive or numeric approaches (21). If the policy approach relies on a numeric standard, it will fail because it pretends to fall within the shadow of scientifically accepted actions but cannot be defended by science.

Discussion

The need for and the value of using precaution-based policy approaches such as

the cautionary approach or prudent avoidance has been controversial. The basis for the controversy is that these approaches are viewed as overly subjective and biased against using the best available scientific or technological information, and they lack natural boundaries to their costs (22). We would argue that these approaches are valuable because they are accessible to individuals and organizations prior to formal societal actions. Coupled with an inclusive process, these policy approaches are seen to be addressing peoples' concerns rather than simply waiting for more formal science-based regulation. This will ultimately increase the support for and use of formal science-based standards and guidelines.

There is an enormous value to society in using the scientific method when formulating decisions. Its use helps to define the need for, use, and value of precaution-based policy approaches. The scientific method provides the tools for implementing precaution-based policies. Without this basis, we run the risk that policy will be developed solely in the domain of perception. Using individual perception of risk as a basis for taking action inherently undermines rational decision making and makes individual and institutional actions unduly influenced by advertising strategies. Reliance on perception of risk rather than informed decision making when taking action would lead to inefficient individual and society policy decisions. Taking actions based on mere possibilities, or unfounded perception, should be avoided and should not be part of a precaution policy approach. With regards to EMF policy, we as a society must try and create a decision-making process that does not require the ad hoc molding of objective truth based on the manipulation of public perception. Providing structure and guidelines for precaution-based policy approaches helps us to achieve this aim.

Within the constraints outlined in this paper, precaution-based approaches are a sensible response both to scientific uncertainty and the concerns of the public. Two traps to avoid are the exclusion of affected parties from the decision-making process and the attempt to shroud our uncertainty about the existence of a risk and the relevant exposure characteristics in potentially obscure science-based arguments. Interim policies that respond to scientific uncertainty should be indifferent to the ultimate outcome of the health question (that is, they

should not presuppose the connection between exposure and disease), they should be flexible, and they should be derived from the input of the full range of affected groups. It is valuable to expand our understanding, application, and evaluation of these policy tools so that they can be used more effectively by decision makers continuing to struggle with responding to uncertainty. Carefully used, precaution-based policy approaches provide an excellent supplement to existing science-based exposure guidelines without compromising the legal or public policy positions of those who use them.

Precaution-based approaches should result in policies that help create desirable futures for society. Our fundamental goals are to increase cultural and societal trust in our scientific and regulatory authorities (23), improve the use and understanding of the scientific methods when responding to complex issues (24), and avoid ineffective risk regulation and inappropriate litigation (25).

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